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INFLUENCE OF FOOD QUALITY ON REPRODUCTION AND LONGEVITY OF *CRYPTOPYGUS THERMOPHILUS* (ISOTOMIDAE : COLLEMBOLA)

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Under experimental conditions *Cryptopygus thermophilus* survived and reproduced when fed at 30 ± 1°C with four different type of food materials like baker's yeast, the fungus *Agaricus* sp., decaying leaves of the jack fruit tree (*Artocarpus integrifolia*) and decaying leaves of *Eupatorium* sp., the latter three food types being obtained from the habitat of the insect. Employing the technique of analysis of variance it was observed that the influence of the quality of food (in the above order of the food types) was very high on mean clutch size (39.93 eggs, 32.63 eggs, 19.53 eggs and 19.7 eggs respectively per female) $F = 114.3$; on the mean logevity of the female (139.29 days, 119.9 days, 111.9 days and 64.6 days respectively) $F = 98.75$; on mean fecundity (489.3 eggs, 365.6 eggs, 230.2 eggs and 106.0 eggs per female respectively) $F = 50.12$ and on mean reproductive period of the female (106.3 days, 87.7 days, 83.9 days and 35.1 days respectively) $F = 42.28$, all F values being significant at 1% level, while the ifluence was appreciably high on the mean number of ovipositions (12.8, 12.4, 12.7 and 5.3 respectively) $F = 10.53$, significant at 5% level. Yeast was apparently the most suitable food and *Eupatorium* leaf diet was least suitable, while the fungus, *Agaricus* sp., and decaying leaves of *Artocarpus* were having intermediate levels of suitability. One possible ecological consequence of the influence of the two leaf diets is that *C. thermophilus* can be expected to maintain a comparatively high population in a site dominated by *Artocarpus integrifolia* compared to a site dominated by *Eupatorium* sp.

(*Key words:* Collembola, *Cryptopygus thermophilus*, biology, yeast, leaf diet, reproduction, longevity)

INTRODUCTION

Diverse environmental factors are known to influence the reproductive phenomena and life of Collembola (CHRITIANSEN, 1964; BUTCHER *et al.*, 1971) of which the influence of the quality and quantity of food is necessarily decisive. Presuming that in nature plently of food is available for Collembola, at least during the favourable season, it would be valuable to have an idea of the influence of the quality of food on reproduction and duration of life of these insects. Previous study on the food of tropical Collembola indicated some amount of diversity in the food habits of these insects (MURALEEDHARAN & PRABHOO, 1978) but the above study did not cover the assessment of food suitability and hence the present study was planned in *Cryptopygus thermophilus*, a collembolan having cosmopolitan distribution. In this study a comparison is made of three types of food materials available in the habitat of the insect with yeast, which is a standard food substance on which Collembola in general are reared in laboratory studies.

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MATERIALS AND METHODS

Live animals were obtained from an abandoned field at Kariavattom from soil and litter by dry funnel extraction method. They were kept in plastic containers with plaster of Paris-charcoal base (SNIDER *et al.*, 1969) with baker's yeast as food and a stock culture was developed, acclimatised to laboratory conditions.

For experimental purposes pairs of freshly laid eggs from the stock cultures were transferred to smaller culture vials (4 × 3.5 cm). Vials which happened to contain a male and a female were kept in a large glass walled chamber with blinds to control the light and maintained in the laboratory temperature 30 ± 1°C. Food materials offered were baker's yeast pellets, the fungus *Agaricus* sp.. decaying leaves of jack fruit tree *(Artocarpus integrifolia)* and decaying leaves of *Eupatorium* sp., a weed, the latter three being obtained from the field. Food was changed every third day and the plaster of Paris base was kept saturated with moisture. Observations were made twice daily. Influence of the food quality on various aspects of biology was statistically analysed employing the technique of analysis of variance (ANOVA).

OBSERVATIONS

Female *C. thermophilus* attained sexual maturity after the fifth moult and the sixth instar began to oviposit. Eggs were generally laid in a cluster. Each oviposition was preceded by a moult, rarely an adult moult was not followed by an oviposition during the reproductive period. Table 1 gives data on various aspects of biology of the insect studied here. Quality of food evidently influenced total number of ovipositions. Variations in the mean clutch size under the above conditions was very significant. Similarly significant differences were noted in the mean fecundity. Quality of food, however, did not affect appreciably the embryonic and postembryonic development. The incubation period, first, second and third instar were respectively 3.4, 3.0, 2.5 and 2 days' duration on different types of food. Duration of the fourth instar was 2.0 days on yeast, and 1.5 on other foods while the duration of the fifth instar was 3.0 days on *Agaricus* and *Eupatorium* leaves, 3.1 days on yeast and 3.9 days on *Artocarpus* leaves. Total duration of embryonic and postembryonic development was 12.0 days on *Agaricus* and *Eupatorium* leaves, 12.6 days on yeast and 12.9 days on *Artocarpus* leaves. Differences noted in the total duration of embryonic and postembryonic life on different types of food were not significant at 5% level ($F = 2.35$). In the adult life of the female the reproductive showed period significant differences on different diets.

DISCUSSION

Collembola are known to lay eggs before they attained maximum adult size. Some species like *Lepidocyrtus lanuginosus* (HALE, 1965 b) started ovipositing in the fifth instar or even earlier as in *Tullbergia krausbaueri* in which the eggs were laid in the third instar (HALE, 1965 b). In *C. thermophilus* only the sixth instar started laying eggs as was found to be the case in *L. orientalis* (PRABHOO, 1967) and *Folsomia candida* (SNIDER & BUTCHER, 1973). The latter study indicated that although the mean juvenile period (pre-reproductive period) was 27.5 days, 17.7 days and 20.6 days at 15°C, 21°C and 26°C respectively, this variation had no influence on the instar starting to lay eggs. Present investigation revealed that apparently the food quality also had no influence on the instar starting oviposition and further there was only insignificant variation in the pre-reproductive period of the female under different diets.

Existence of a relationship between moulting and oviposition was reported in Collembola, which shared this feature with other arthropods in which moulting is

TABLE 1. Summary of observations on aspects of biology of *Cryptopygus thermophilus* reared at 30±1°C on four types of food. (Data pertains to the female only).

Type of food	No. of oviposition	Clutch size (No. of eggs per oviposition	Fecundity	Reproductive period in days	Post-reproductive period in days	Longevity in days	
	7	29.55	266	71	5	121	Min.
Yeast	23	43.9	921	143	40	161	Max.
	12.8	38.93	498.3	106.3	21	139.25	Mean
	10	30.64	327	81	15	115	Min.
Agaricus	13	33.09	430	96	22	116	Max.
	12.4	32.63	365.6	87.7	20.8	119.9	Mean
	7	13.4	164	71	3	110	Min.
Artocarpus	22	32.2	323	109	53	124	Max.
leaves	12.7	19.53	230.2	83.9	24.1	111.9	Mean
	4	13.6	68	23	3	65	Min.
Eupatorium	8	24.3	167	41	29	75	Max.
leaves	5.3	19.7	106	35.1	17.5	64.6	Mean
F value	10.53^{+}	114.33^{++}	50.12^{++}	42.28^{++}	0.48*	98.75^{++}	

For each category n = 10; * not significant; + significant at 5% level; ++ significant at 1% level.

continued duriug adult life (PALEVODY, 1976). Possible lengthening of intermoult duration consequent to the interference by vitellogenesis was indicated by THIBAUD (1970). It appears from the previous studies that there are two distinct patterns of relationship between moulting and reproduction in these insects. In some species like *T. krausbaueri*, *Dicyrtoma fusca* and *D. minuta* (HALE, 1965 a), *L. orientalis* (PRABHOO, 1967) etc., the adult females laid eggs after each moult during the reproductive period. On the other hand egg laying occurred only in alternate instars as in *Isotoma viridis*, *Tomocerus minor* (JOSSEE & VELTKAMP, 1970), *Sinella curviseta* (WALDORF, 1971) and in *F. candida* (SNIDER & BUTCHER, 1973). This would mean that in these latter species there are alternate productive and non-productive instars. PALEVODY (1976) in a very interesting and detailed study clarified this relationship in *F. candida* and has shown that in this insect the first moult preceded vitellogenesis and the second moult occurred just before the oviposition. May be this is not a universal feature in Collembola. *C. thermophilus* falls in the first category as in this species oviposition was found to occur after every moult during the reproductive period. In *F. candida* oviposition takes place within 48 hours of the alternate moults (SNIDER, 1973). In *C. thermophilus* it may occur within 12 hours after every moult during the reproductive period. There is considerable variation in the number of ovipositions during the life time of female Collembola. HALE (1965 b) has summarised information on this aspect

from previous workers and the probable number of clutches were found to vary from 2-10. Mean number of ovipositions noted in *T. krausbaueri* and *Orchesella villosa* are reported to be 10. However, *F. candida* oviposited 13 times (mean) at 15°C and 21°C but only five times (mean) at 26°C thus indicating that temperature influenced the number of ovipositions (SNIDER & BUTCHER 1973). This latter is perhaps a general effect that temperatures near lethal point, increased instar duration and shortened life of Collembola (THIBAUD, 1970) thus leading to fewer oviposition. Present study showed that although the mean number of ovipositions was more or less the same (12.4—12.8) on yeast, *Agaricus* and *Artocarpus* diet, it was reduced to half (5.3) on *Eupatorium* diet and that this difference was significant statistically. Optimum temperature and optimum food quality thus appear to ensure high mean number of ovipositions. It is interesting to note that there was a steady decrease in the mean reproductive period under different diets from yeast to *Eupatorium* leaf in *C. thermophilus*.

A definite reproductive period noted in *C. thermophilus* was not observed in *F. candida* (SNIDER. 1973). Clutch size (number of eggs in one oviposition) in *F. candida* showed considerable individual variations and was found to be influenced by temperature, the relationship being inverse. Fecundity (total number of eggs laid by a female during its life time) was found to be on an avarage of 1344 eggs at 15°C, 1011 at 21°C and 130 at 26°C (SNIDER & BUTCHER, 1973). A high realized reproductive rate was suggested for Collembola on ideal food (BOOTH & ANDERSON, 1977; JOSSEE & TESTERINK, 1977). Present study showed that on favourable food both clutch size and fecundity were high and food quality was found to have very significant influence on both the charateristics. Longevity of Collembola was found to be very much affected by temperature (THIBAUD, 1970; SNIDER & BUTCHER, 1973), high temperatures shortenig the life span. Present study revealed that longevity can also be affected by food quality and that a progressive shortening of life span was noted in females fed on yeast, *Agaricus*, *Artocarpus* leaf and *Eupatorium* leaf. It also emerges from the present study that food quality could play a decisive role in different aspects of the biology of Collembolan *C. thermophilus*. This has also possible ecological consequences. Thus one can logically predict a higher population density of *C. thermophilus* in a habitat dominated by *Artocarpus integrifolia* compared to a habitat where the prominent plant species is *Eupatorium*.

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